REMARKS

Applicants respectfully acknowledge receipt of the Office Action mailed March 31, 2008.

In the Office Action, the Examiner rejected claims 1-5 and 14 under 35 U.S.C. § 103(a) as being unpatentable over *Halman et al.* (U.S. Patent No. 5,658,425) in view of *Li et al.* (U.S. Patent No. 6,284,149).

No claim is amended herein, and claims 1-5 and 14 remain pending. Of these claims, claim 1 is independent.

Applicants traverse the rejection above and respectfully request reconsideration for at least the reasons that follow.

I. 35 U.S.C. § 103(a) REJECTION

Claims 1-5 and 14 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over *Halman* in view of *Li*. Applicants respectfully disagree with the Examiner's arguments and conclusions and submit that independent claim 1 patentably distinguishes over *Halman* and *Li* at least for the reasons described below.

In order to establish a *prima facie* case of obviousness under 35 U.S.C. §103(a), the prior art reference (separately or in combination) must teach or suggest all the claim limitations. *See* M.P.E.P. § 2142, 8th Ed., Rev. 5 (August 2006). "[I]n formulating a rejection under 35 U.S.C. § 103(a) based upon a combination of prior art elements, it remains necessary to identify the reason why a person of ordinary skill in the art would have combined the prior art elements in the manner claimed." *USPTO Memorandum* from Margaret A. Focarino, Deputy Commissioner for Patent Operations, May 3, 2007, p. 2. "[T]he analysis supporting a rejection ... should be made explicit" and it is

"important to identify a reason that would have prompted a person of ordinary skill in the relevant field to combine the [prior art] elements in the manner claimed." Id. (citing *KSR Int'l Co. v. Teleflex, Inc.*, No. 04-1350 (U.S. Apr. 30, 2007)).

Halman appears to disclose a process for etching a silicon oxide, such as silicon dioxide, or oxynitride. The process includes etching a silicon oxide layer to expose an underlying electrically conductive titanium silicide layer and provide a contact opening extending through the silicon oxide layer to the electrically conductive titanium silicide layer. The etching is performed by exposing the silicon oxide layer to an etching gas. The etching gas includes a fluoride-containing gas and a passivating nitrogen gas. (*Halman*, Abstract). Furthermore, *Halman* discloses that the flow rate of nitrogen can be as low as 2 sccm, and the flow rate of the fluoride-containing gas can be 10 to 100, preferably 40 to 60 sccm. "Although there is no upper limit on the amount of nitrogen which can be added to the gas due to the highly reactive nature of the nitrogen . . ., the maximum amount of nitrogen should be controlled to prevent the equipment from wearing out and/or showing the etching of the silicon dioxide layer to an undesirable level." (*Halman*, col. 4, ll. 52-58).

However, as admitted by the Examiner, "*Halman* does not teach using between 1 and 4 times as much N_2 as CF_4." (*Office Action*, p. 2, line 20). *Halman* also fails to teach or suggest wherein a processing gas has a selection ratio greater than approximately 2.0, the selection ratio defined by an etching rate of the organic etching target film divided by an etching rate of the resist layer.

As disclosed in Applicants' specification on page 13, lines 6-30, "an etching process is implemented by adjusting the flow rate ratio of CF_4, N_2, and Ar, respectively

at (a) 50:200:300, (b) 50:100:300 and (c) 50:50:300, to form contact holes at the layer insulating film of the wafer W . . . [T]he flow rate ratio (b) CF_4:N_2 = 50:100 = 1:2 achieves the most desirable results, . . . the flow rate ratio is set essentially within a range of 1 ≤ (N_2 flow rate / CF_4 flow rate) ≤ 4." For the flow rate ratio represented in example (b) above, the volume percentage (vol% (density)) of N_2 is essentially 22 vol% (or 100/450). Accordingly, in the present invention, the volume percentage of N_2 is approximately four times greater than that disclosed in *Halman*. *Halman*, for example, discloses that, "the etching gas can include an effective amount up to 5 volume % N_2. . ." (*Halman*, col. 4, ll. 40-41). The incomparably larger flow rate and vol% of N_2 in the present invention is due to the focus on improvements in the selectivity and in the etching shape, whereas the focus of *Halman* is to prevent over-etching.

The Examiner further asserts, "Halman and Li do not teach an etching selectivity ratio of 2 with respect to the resist; however, as Halman and Li make obvious the claimed process it is expected the skilled artisan would achieve the same results." (*Id.* at p. 3, ll. 7-9). Applicants respectfully disagree.

Applicants' specification on pages 1-2 discloses that "[t]he resist-relative selection ratio in this context refers to the value expressed as (average etching rate of the etching target film) / (etching rate of the photoresist) and hereafter it is simply referred to as the 'selection ratio.'" Since the etching rate of the etching target film and the etching rate of the resist layer varies and depends on the composition of the target film and the resist layer, and since the "selection ratio" is dependent on the mixture of gases present in the processing gas, there is no disclosure in *Halman* to suggest that it would be obvious to one of ordinary skill in the art to combine all of the variables noted

above to produce and use a processing gas which has a selection ratio greater than approximately 2.0.

Thus, in order to cure the deficiencies of *Halman*, the Examiner relies on *Li* for its alleged disclosure of "adding a substantial amount of N_2 to a fluorocarbon based plasma etching of Si-containing organic layer . . ." (*Office Action*, p. 2, ll. 21-22).

Li appears to disclose a plasma etching process for etching a carbon-based low-k dielectric layer in a multi-layer inter-level dielectric. The low-k dielectric may be BCB, which contains about 4% silicon, the remainder being carbon, hydrogen, and a little oxygen. The BCB etch uses an etching gas of oxygen, a flurocarbon, and nitrogen, but <u>no</u> argon (emphasis added). (*Li*, Abstract). The multi-layer inter-level dielectric includes a substrate 10, a lower stop layer 14, a low-k lower dielectric layer 16, an upper stop layer 18, a low-k upper dielectric layer 20, and a hard mask layer 42. (*Id.* at col. 6, line 56 - col. 7, line 31).

Li, however, fails to explicitly teach or suggest wherein a flow rate ratio of CF_4 and N_2 in a processing gas is set within a following range: (N_2 flow rate / CF_4 flow rate) ≥ 1 to prevent an occurrence of an etching stop and (N_2 flow rate / CF_4 flow rate) ≤ 4 to prevent an occurrence of bowing. Furthermore, *Li* fails to teach or suggest wherein a processing gas has a selection ratio greater than approximately 2.0, the selection ratio defined by an etching rate of the organic etching target film divided by an etching rate of the resist layer.

The Examiner alleges that "Li teaches that adding N_2 to a fluorocarbon based plasma etching of a Si-containing organic layer allows one to control the etching profile, for example, to prevent bowing . . ." Such teaching, even if present in *Li*, which

Applicants do not necessarily concede, however, fails to teach or suggest wherein a flow rate ratio of CF_4 and N_2 in a processing gas is set within a following range: (N_2 flow rate / CF_4 flow rate) ≥ 1 to prevent an occurrence of an etching stop and (N_2 flow rate / CF_4 flow rate) ≤ 4.

The Examiner further asserts that, "Halman and Li do not teach an etching selectivity ratio of 2 with respect to the resist; however, as Halman and Li make obvious the claimed process it is expected the skilled artisan would achieve the same results." (*Id.* at p. 3, ll. 7-9). Applicants respectfully disagree.

Applicants' specification on page 3 discloses that "a selection ratio of approximately 5.8 is achieved by using a mixed gas containing CF_4, N_2, and Ar..." Since the Examiner admitted that "Li does not teach using CF4 as the fluorocarbon etchant or including Ar as a component of the etching gas mixture," in the Office Action mailed on December 12, 2002, there is no suggestion or motivation in *Li* to disclose, "wherein the processing gas has a selection ratio greater than approximately 2.0...," as required by independent claim 1, because *Li* fails to teach all of the elements of claimed the processing gas, namely CF_4 and Ar.

Accordingly, with respect to independent claim 1, *Halman* and *Li* fail to teach or suggest the claimed combination, including, *inter alia*:

> wherein a processing gas has a selection ratio greater than approximately 2.0, the selection ratio defined by an etching rate of the organic etching target film divided by an etching rate of the resist layer.

With respect to independent claim 14, *Halman* and *Li* fail to teach or suggest the claimed combination, including, *inter alia*:

> wherein a flow rate ratio of CF_4 and N_2 in the processing gas is set within a following range: (N_2 flow rate / CF_4 flow rate) ≥ 1 to prevent an occurrence of an etching stop and (N_2 flow rate / CF_4 flow rate) ≤ 4 to prevent an occurrence of bowing.

For at least the foregoing reasons, a *prima facie* case of obviousness has not been established with respect to independent claims 1 and 14. Accordingly, independent claims 1 and 14, and claims 2-5 that depend from claim 1, are patentable over *Halman* and *Li*. Applicants therefore request that the rejection of claims 1-5 and 14 under 35 U.S.C. § 103(a) be withdrawn.

II. CONCLUSION

Applicants respectfully submit that claims 1-5 and 14 are in condition for allowance.

The Office Action contains characterizations of the claims and the related art with which Applicants do not necessarily agree. Unless expressly noted otherwise, Applicants decline to subscribe to any statement or characterization in the Office Action.

In view of the foregoing remarks, Applicants respectfully request reconsideration and reexamination of this application and the timely allowance of the pending claims.

Please grant any extensions of time required to enter this response and charge any additional required fees to our Deposit Account 06-0916.

Respectfully submitted,

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